THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF MINING ENGINEERING

FIRST SEMESTER EXAMINATION – 2022

2ND YEAR MINING ENGINEERING & 2ND YEAR MINERAL PROCESSING ENGINEERING

# MN212 – THERMO-FLUIDS

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| DATE: | THURSDAY ~~5TH~~ 2nd JUNE 2021 |
| TIME: | 12:50 PM |
| TIME ALLOWED: | 3 HOURS |

## INSTRUCTION TO CANDIDATES:

1. YOU HAVE **10 MINUTES** TO READ THE PAPER. **DO NOT** WRITE DURING THIS PERIOD

2. THERE ARE FOUR QUESTIONS. **ATTEMPT ALL**. WRITE ANSWERS IN THE ANSWER BOOKLET PROVIDED.

3. WRITE YOUR **NAME** AND **NUMBER** CLEARLY ON THE **ANSWER BOOK**. DO THIS **NOW.**

## MARKING SCHEME:

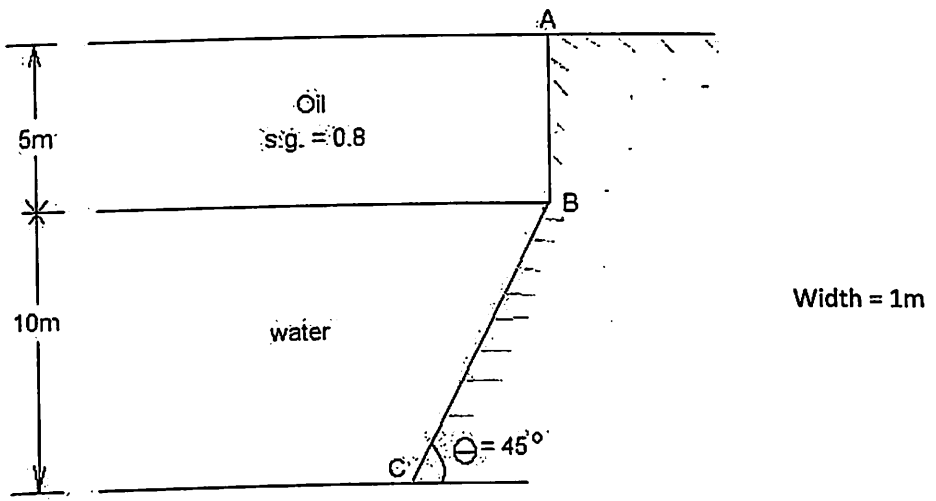
**THE QUESTIONS CARRY EQUAL MARKS. TOTAL MARK IS 100**

## QUESTION ONE

(a) Define the following terminologies and where necessary with illustrations and equations (**2 marks each**)

(i) Thermal systems
(ii) Newtonian & Non-Newtonian fluids
(iii) Viscosity
(iv) Pressure head

(b) Shown is a reservoir for two immiscible liquids, oil and water. Oil has a depth of 5m and water depth of 10m.




Calculate;

(i) The pressure head at the bottom of the tank in terms of water head (**2 marks**)
(ii) The resultant force at BC (**4 marks**) and
(iii) The line of action of the resultant force (**6 marks**)

## QUESTION TWO

(a) Water flows through a pipe AB of diameter, $D_1$ = 100 mm, which is in series with a pipe BC of diameter, $D_2$ = 150mm in which the mean velocity is 1.5 m/s. At C the pipe forks and one branch CD is of diameter, $D_3$ such that the

mean velocity is 3m/s. The other branch, CE of diameter, $D_4$ = 50mm and conditions such that the discharge $Q_2$ at BC divides that $Q_3 = 2Q_4$

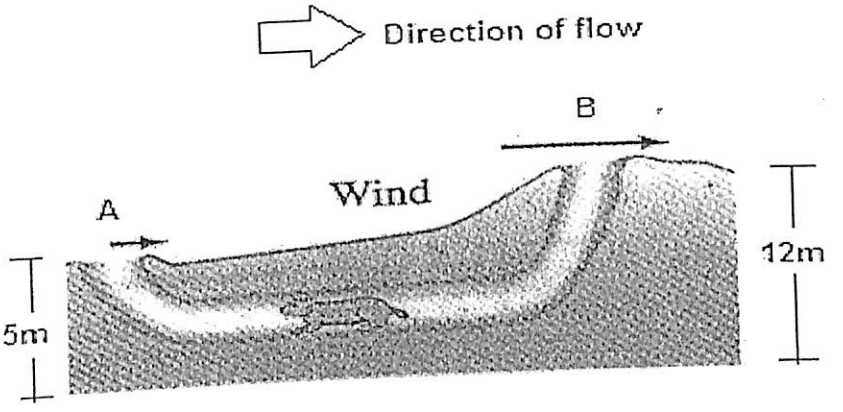
Apply continuity principle and determine the following (**12 marks**);

i. Flow rates at each point, $Q_1$, $Q_2$, $Q_3$ and Q4
ii. The inlet mean velocity, $V_1$ and outlet velocity, $V_4$ at point E
iii. The diameter, $D_3$ of pipe CD

(b) A scenario is illustrated pictorially as shown of a tunnel produced by a rat. The other end of the hole (B) is raised higher as shown thereby causing constriction:

(i) Which end of the hole, A or B will experience low pressure and explain why? (**4 marks**)

(ii) If the rat is inside the tunnel as shown, will it suffocate? Explain your answer (**4 marks**)




## QUESTION THREE

A pipe bend tapers from a diameter of $d_1$ of 500mm at inlet to a diameter $d_2$ of 250mm at outlet and turns the flow through an angle $\theta$ of 45°. Measurements of pressure at inlet and outlet show that $p_1$ = 40 kPa and $p_2$ = 23 kPa.

If the pipe is conveying oil of density, $\rho$ = 850 kg/m$^3$, Calculate the magnitude and direction of the resultant force on the bend when the oil is flowing at the rate of 0.45m$^3$/s (**20 marks**)

## QUESTION FOUR

(a) What is the main driving force for fluid flow in (1) horizontal pipes (2) open channel flows and (3) pipes inclined at angle? **(6 marks)**

(b) Water of density 1000kg/m$^3$ and viscosity of 0.0016 N.s/m$^2$ is flowing steadily through a 3.05mm diameter 9.1m-long horizontal pipe steadily at an average velocity of 0.9144m/s. Determine **(14 marks)**;

(i) The head loss,

(ii) The pressure drop, and

(iii) the pumping power requirement to overcome this pressure drop

## QUESTION FIVE

(a) Define the following terminologies where necessary with examples and illustrations ( **2 marks each**)

(i) Zeroth law of thermodynamics
(ii) 1$^{st}$ law of thermodynamics
(iii) 2$^{nd}$ law of thermodynamics
(iv) Heat Engine
(v) Enthalpy

(b) Sketch a P-V diagram showing the following processes in a cycle **(10 marks)**

*Process 1 – 2:* *Isobaric work output of 10.5kJ from an initial volume of 0.028m$^3$ and pressure 140kPa,*

*Process 2 – 3:* *Isothermal compression and*

*Process 3 - 1:* *Isochoric heat transfer to its original volume of 0.028m$^3$ and pressure at 140kPa.*

Calculate;
(1) The maximum volume (m$^3$) of the cycle
(2) The isothermal work in kJ and
(3) The net work in kJ

*.....GOOD LUCK....END OF EXAM.....*